



*Destia DX rigs at Talvivaara*



# The hole truth

Automation is always a topic and here also John Chadwick looks at a number of developments in drilling tools

In a surface drilling feat that may never be surpassed, Schramm has received worldwide acclaim for its contribution to the historic and unprecedented rescue, more than two months ahead of the date expected, of the 33 trapped miners in Copiapo, Chile in October last year. Schramm model T685 and model T130XD rigs truly made a difference, as noted in *IM*, November 2010, p8.

Schramm says it "is the market leader in top head drive rotary drilling rigs based on advanced hydraulic automation."

Automation has been one of the great thrusts recently and Sandvik's latest development is TIM 3D, a drill rig navigation system that brings drilling rigs into the realm of 3D machine automation. It is an operator aid consisting of three essential operations: Rig navigation, feed alignment and drilling.

Sandvik says "TIM 3D improves hole quality and hole position accuracy, translating into better fragmentation. This results in increased efficiency further in the production process, both in crushing and loading and hauling." The system also removes the need for surveying and removes the risk of marking errors, significantly speeding up drilling. With a modern and clear user interface, the system is easy to use.

Based on multi-satellite RTK GNSS navigation, TIM 3D is compatible with GPS and GLONASS satellite systems. It uses drilling plans made either with standard office programs or with the system itself. The plan is imported to the rig with a USB memory in IREDES standard format, containing the target co-ordinates in 3D. Local base station, or VRS

correction, keeps navigation accuracy within 100 mm.

TIM 3D makes the drilling process easier for the operator. The system compares the position of the drill bit with the planned hole position and guides the operator to the correct starting point for the chosen hole. During drilling, the operator can follow penetration rate and hole depth, distance to target, number of required holes and current feed alignment. Furthermore, drilling stops automatically at the target depth. The system also shows the status of the holes with colour codes.

TIM 3D allows the operator to deviate from the drill plan if needed, for example due to an inappropriate planned starting point. Despite such a modification, the bottom of the hole remains as planned – the system automatically calculates a new course based on the actual starting point of the hole.

The drilling data – the actual parameters - are stored in the system memory, from where it can be imported to various programs, such as blasting simulation. The data includes a quality report, position and depth of the drilled holes, drilling time, and start and end points.

The TIM 3D navigation system is available for Sandvik DPI and DX series surface top hammer drill rigs.

Destia, a pioneer in 3D machine automation in Finland, has been keenly involved in developing the 3D navigation system for drilling rigs with Sandvik. "Destia has, since 2007, systematically been making use of machine automation in the excavators,

loaders, bulldozers and road graders used at the company's construction sites." Automation has been used in drilling at the Talvivaara nickel mine (*IM*, November 2008, pp8-14), Juho Torvi, Development Engineer in Destia's Rocks unit, explains.

The first TIM 3D system installation for a customer was a retrofit for Destia's approximately one-year-old Sandvik DX780 drill rig. Due to its mobility, the DX series rig is easy to test out in various sites. Destia's rig has already been tried out at a road construction sites and now at Talvivaara.

"Three different sites, and everything has gone smoothly. We worked right next to road traffic on a highway project so it was crucial that the holes be precisely aligned in order to achieve the briefest traffic stops possible. The system's tolerance to below-zero temperatures was also put to the test straight away, as at the time it was -25°C. It didn't cause any problems," Torvi recounts.

"The most important thing is that drilling accuracy is now better than before," says Torvi. "Thanks to the 3D navigation, the drill



*Secoroc PARD in Aitik mine, Sweden*

hole bottoms are precisely in the right place, thereby making the pit floor even more even.

"The accuracy has been even more precise than expected – and considerably better than with the traditional method. In the xyz position, the accuracy has been within 5–10 cm, and sometimes we have even achieved less than 5 cm. The joints of the booms must be very stiff to ensure good dimensional accuracy. Now all

of the holes are perfectly aligned. This parallel accuracy is highlighted when several operators work in the same field, because their individual 'fingerprints' are eliminated.

"Drilling diagrams are made in advance on the computer and then imported to the drilling rig. When drilling, however, it is possible to deviate from the plan; for example, moving holes or making entirely new ones. The as-drilled data is again imported to the office.

Destia has its own reporting tool. Since planning and marking are basically no longer carried out in the pit, the drilling work is substantially boosted. The driller can stay in the control cabin," Torvi explains.

"The basic functions of TIM 3D can be learned rather quickly, but it takes a bit more time to learn all of the system's finer points. Drillers are accustomed to using computers, however, and they will learn to use the 3D system too," says Torvi.

Aki Laurila, a driller for Destia with over ten years' drilling experience, learned how to use the system in quite a short time frame. "Just like using a computer, this is easy to learn. The system sure did speed up the drilling work; now I don't need to jump outside anymore except maybe to change the drill bit. And the system is already quite reliable, even though it hasn't been in use for very long. Now that I've learned to use the system, I would much rather drill with it than without it."

At Talvivaara, aside from Destia's drilling work, the mining company is using three Sandvik DP1500i drill rigs for the production drilling. Last spring, these machines, which had been in use for around two years, were equipped with the TIM 3D system.

"The work has become more efficient and the quality has improved," says a pleased Lauri Sarajärvi, a mine planner. "And the operators are also happy with the navigation system; they feel that it has made their work easier. The precision is good – we have come within 8 cm accuracy."

The survey team has a similar measuring device, but combined with the drilling equipment, it eliminates marking errors and the holes are correctly aligned. When it's dark, and particularly in the winter, the benefits of the system are highlighted, since the work is no longer dependent on sight."

"We crush ore down to 8 mm for the bio heap leaching process," says Sarajärvi. "Good fragmentation is achieved with a precisely accurate course in the blasting. It is very

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significant that we can now get a more even pit floor with fewer irregularities, since the bottom of the holes are now precisely in the right place. A level pit floor makes loading and movement in the area easier, and it also saves tyres, which is significant, considering the high cost of big mining tyres. It also makes it easier to drill in the next field."

Sarajärvi is looking to the future. "We are anxiously awaiting a wireless data transfer system. Data transfer with a USB memory stick is a bit slow compared to wireless transfer. With real-time data, we would know exactly at what stage the drilling is in a given field, and it would help us to make coordination of the charging work more efficient."

Jouni Sirviö has been training the rig operators at Talvivaara mine. "Every driller has been guided through the TIM 3D system individually. The drillers like the system a lot, since it simplifies the work and allows them stay in the cabin for a greater proportion of the work day – they no longer need to hop out of the cabin to spray marks on the rocks. The drill hole lines in the field are now visibly straighter. If the drilling could be made a bit smoother, then the product would be exceptional. This is the best innovation for drilling rigs since the hydraulic top hammer and cabin," says Sirviö.

At a copper grade of just 0.25% Aitik (*IM*, December 2010, pp12-20) has to be efficient. There is a paramount need for efficiency and mobility in drilling. The fleet is comprised of four Atlas Copco Pit Viper PV-351E rotary drill rigs, owned and operated by Boliden, and a SmartROC D65 and ROC L8, owned and operated by mining contractor NCC. The four Pit Viper rigs handle the production drilling while the ROC L8 and SmartROC handle the presplit drilling with their down-the-hole hammers. The Pit Viper PV-351E rigs drill 17–20 m deep, 311 mm blast holes on 15 m benches and benefit from advanced communication and automation technology.

Peter Palo, Boliden's Production and Service Superintendent says one reason for choosing the Pit Viper was that with "features such as GPS, autotramming and wireless communication, we came to the conclusion that these were the most advanced rigs of their kind on the market."

Some of the advanced features used at the mine today include GPS and Hole Navigation which shows the rigs' exact position in relation to the drill plan, as well as wireless transfer of the mine's drill plan directly to the rigs.

Another feature of these rotary rigs that contributes to productivity is the ability to

lower the drill tower in just five minutes. "It used to take a full shift to do this with the older rigs we had before," says Palo. "But the Pit Viper can go from drilling to tramming in just five minutes." The Pit Vipers move regularly between benches.

The typical hole spacing used drilling vertical holes is 7 x 9 m in waste rock and 6.5 x 8.5 in ore. Palo explains: "We had an initial goal of averaging 27 m/h with these rigs but we are already beyond that with a net penetration rate of 33 m per hour or 144 m per eight-hour shift."

Hanna Wikman, one of the drill operators says "the controls are well placed and the screen shows all the drilling data you need. I can quickly see engine hours, drill speed, rpm, pulldown pressure, and so on. I use the GPS to locate my position in relation to the drill plan that is sent wirelessly from the control centre. I also use the auto de-levelling feature.

Sandvik recently added the Cubex QXR line of high-power DTH drills to its surface drill range. This re-named DR500 series consists of three fully self-contained, diesel-powered, high-pressure DTH drills. They are used across a broad range of applications including production blastholes, pre-split drilling as well as pioneering and pit dewatering. These drills respond to the growing demand for Reverse Circulation (RC) drilling for In-pit grade control

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and shallow exploration. The DR500 is best known for its robust design, matched with powerful compressors. A full range of engine and compressor configurations allow the machines to be optimized for 4", 5", 6" and 8" DTH hammers.

Operating pressures up to 34.5 bar are especially important in drilling in hard rock as it maximises the penetration rate. On the other side, when drilling in softer rock or broken ground, it's a huge benefit to have a big air volume available for flushing. The selection of high pressure/less air volume or less pressure/high volume can be made by a switch in the operator's cab, during drilling, in order to maximise drilling results.

The drills have a small footprint, are crawler-mounted (with no jacks) and tilting booms and feeds for maximum flexibility. With track oscillation of  $\pm 10\%$  and gradeability greater than  $30^\circ$ , they are nimble, steady and able to promptly move from hole to hole (tram speed of 5 km/h). Engines are available with outputs of 403, 641 or 708 kW.

With its vast boom swing range, the DR500 series proves itself in angle drilling applications, and even horizontal drilling is possible. The swing boom cab ( $360^\circ$  visibility) can be located away from the face, high walls or other potentially difficult situations.

Wolfgang Tronegger, Product Line Manager, says "the outstanding productivity and reliability of these drill rigs is well known with many customers reporting exceptional service and extended drill life. They can expect better



*More than just a sensor, ASI's 3D spinning laser product includes intelligent filtering and slope/change detection to deliver real-time traversability maps with high accuracy and update rates suitable for autonomous navigation.*

*ASI says it "has just delivered two of these units to one of the world's largest manufacturers of mining equipment for use in their autonomous vehicle offerings. These units will be field tested in Sweden throughout the first half of 2011, leading to continuing product sales in the mining market"*

results with the addition of the Sandvik service and support network."

One of the most volatile components of a drill's cost is fuel. Fuel prices fluctuate but the trend is mostly upward, and that will surely continue that way. Sandvik has engineered a Compressor Management System (CMS) that enables a drill to minimise the amount of air used at different stages of the drilling operation; less air, less engine activity, less fuel. More profits.

The concept is simple: the compressor runs at full volume only when needed. Grant Field, Automation Product Line Manager for Surface Mining, describes it this way. "Normally, when you drill, you have maximum volume regardless of the drilling condition, because the compressor control is geared toward pressure and not volume. When there is no drilling, maximum pressure loads the engine for no benefit. With the CMS, when drilling, the system delivers the pre-determined amount of flushing air within seconds; and when not drilling, the hydraulically driven evacuation pump extracts all air from main compressor, eliminating cooling needs for the compressor. Similar benefits are found at start-up and shut down."

The impact can be pretty dramatic – an annual reduction of up to 33% in fuel consumption per machine. Since the engine is used less, it will last longer, and maintenance

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intervals will be further apart with fewer replacement parts used.

All this should happen without a loss of productivity. In fact, a machine that has been operating with CMS in Australia has repeatedly seen productivity per shift increases, breaking record after record.

Says Field, "Fuel is costly, but it is also a pollutant. So, when you use less fuel, you are allowing fewer noxious emissions to get into the atmosphere. Depending on calculations, it could be upwards of 33% savings. It's a nice thing to be able to talk about with your community, even while you know it is actually saving you money".

## DTH/rotary tools

Atlas Copco Secoroc's latest innovation in rotary drilling is the PARD system - which according to the group- is designed to boost rotary drilling performance by combining the best of DTH and rotary drilling technology. It is targeted for use in large mines, where blastholes from 250-311 mm are standard. There are two models currently available: Secoroc PARD 10 and Secoroc PARD 12 - as well as a comprehensive selection of Secoroc PARD tricone bits.

The new system combines "a unique, high frequency, low impact DTH hammer and a specially designed tricone drill bit" that are mounted onto a standard rotary drill rig and drill string. The result says Atlas Copco is a combination of percussive power and rotational force that provides significant increases in the rate of penetration (ROP). Case studies have shown ROP increases up to 50%.

The PARD hammer is designed to operate on pressures from 3.45 to 7.6 bar, which is low compared to standard DTH hammers. Optimal air flow is achieved with the unique Secoroc PARD parallel air flow system, which distributes the air proportionately between the hammer and the tricone drill bit. The tricone bits can withstand the additional stresses and strains and still retain the same service lives of standard tricone bits, according to Atlas Copco.

The combination of low impact percussion and rotational force increases penetration rates. At Aitik, field tests of the PARD system increased drilling rates by 48% and extended bit life by more than 100%. Commenting on the tests, Palo is enthusiastic. He says: "I think it is the biggest advance in rotary drilling for the last two decades."

The new Secoroc Omega sealed bearing tricone drill bit is machined with close tolerances, features innovative and patented seal technology, and employs premium lubricants and proprietary materials and

processes. In case studies, the Secoroc Omega has been shown to reduce overall drill bit usage by as much as 55% thanks to reduced bit changes and longer bit life. A new cutting structure utilising a patented insert package provides additional cone erosion protection. This places smaller inserts in between larger inserts providing erosion reduction and thereby longer bit life.

Patented excluder seals help protect bearings by keeping contaminants out, while also maintaining constant bearing lubrication with a heat resistant synthetic lubricant specifically made for high loads and high rpm.

The Omega is made for regular drilling conditions in copper, coal and gold. Sealed bearing bits are best used in applications where bearing failure is the major mode of bit failure. They are also ideal for drilling holes where groundwater is present or where water injected is in the air stream.

These bits are currently available in 270 and 311 mm diameters. Development continues and the market will soon see 251 mm and 349 mm diameter sizes.

Varel International, a leading manufacturer of drill bits and global supplier to the drilling industry, has completed the acquisition of the Rotary Percussion System (RPS) product line and assets of Renegade Tools. The line of high frequency, low impact percussion hammer tools complements the already robust suite of tools Varel supplies to the mining industry. This product line, under development since 2005, allows drillers to use traditional roller cone or PDC drill bits in air, mist, or foam fluid applications, increasing the rate of penetration through efficiently combining the complimentary forces of both rotary and hammer drilling.

"We are very pleased with the addition of the RPS technology to the portfolio of products Varel brings to the global marketplace" said Jim Nixon, President and CEO of Varel International. "RPS promises to enhance drilling efficiencies for our blasthole mining customers. We look forward to working with the team at Renegade to rapidly bring RPS to market."

Speed Collingsworth, Varel's Vice President for Mining and Industrial products discussed some of the advantages of the RPS technology, "In field testing in several different applications in the Western Hemisphere we have found that the RPS tools not only increase drilling rate by 25% or more but additionally deliver a straighter, cleaner drilled hole. A cleaner hole reduces the need for time consuming back reaming and a straighter hole improves rock fragmentation during blasting. Better rock

fragmentation improves efficiencies at the crusher reducing costs."

Joe Goebel, Co-Principal for Renegade expressed his thoughts on the transfer of Renegade's RPS technology, "Varel's unique position in the mining supply industry coupled with its global reach will accelerate the advancement of this new technology into the market. We have developed and evolved RPS over several years and look forward to working with Varel to take it to



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the next stage of delivering results for drilling customers worldwide."

"Varel has the engineering, metallurgy, distribution, and supply chain assets needed to take RPS to the next level," added Ross Bassinger, Co-Principal of Renegade. "Over the past year we have forged a great relationship with Varel that has allowed us to prove the commercial applicability of RPS. Over the coming quarters we will work with Varel personnel to evaluate candidate RPS applications and to fine tune the products to meet customer needs."

Renegade Drilling Tools is a private drilling technology development enterprise based in Austin, Texas. The company focuses on providing solutions to the mining industry through its expertise in impact hammer development.

Mark Baker, Sandvik's Global Product Line Manager for Rotary Tools, notes the enhancement of the Sandvik air bearing product line, adding longevity to drilling tool. The developments, he explains, "are continuous updates on the existing platform. Drillers will recognise the products and will appreciate the performance enhancements. It primarily involves geometry and materials changes in the bearing configuration. The area of focus thus far has been on hard formation bits from 251-406 mm, where the life limiter is often bearing capacity. By focusing on changes to the bearing geometry we have been able to increase bearing hours by 10 to 15% in medium to hard formations, particularly for demanding drilling conditions

where high weight-on-bit and shock loads are prevalent. These changes, combined with implementation of new materials, come as a result of two years of studies in which extensive testing was done in both the lab and in the field. We are in the process of implementing these changes across the portfolio and have patents pending for some very novel ideas. Our customer requirements are becoming more demanding every day continuously focusing on higher productivity and product reliability."

The latest additions to Rockmore International's (global manufacturer of rock drilling tools) ROK Series DTH Hammer product

line are the ROK 500 and 500Q. These new patented 127 mm diameter class hammers will be officially released at CONEXPO-CON/AGG in Las Vegas on March 22, 2011. International Mining is attending that event.

"Our mission is to provide our customers with the finest quality equipment possible, and ensure it integrates fully with their drilling operations," said Pejman Eghdami, Executive Vice President of Rockmore International. "The release of the ROK 500 and 500Q expands the full range of our DTH hammer line from 3" to 8" (76 - 203 mm) diameters." Designed to increase drilling efficiency, the ROK 500 accommodates two different air packages, to



match any working conditions. The ROK 500 hammer is rated for use with large compressors: 24.1 bar (350 psi) at 28.6 m<sup>3</sup>/min. The ROK 500Q hammer is designed for smaller compressors: 24.1 bar at 23.4 m<sup>3</sup>/min.

As with all of Rockmore's DTH hammers, the 500 and 500Q take full advantage of Rockmore's patented SonicFlow technology, which optimises airflow by simplifying and streamlining the air path to minimise backflow and turbulence, thus delivering more energy to the piston. Optional back reaming buttons on the Top Sub offer increased drill life. Field testing of the SonicFlow design was found to result in faster penetration rates and greater overall efficiency.

The ROK 500 and 500Q have been built to withstand the toughest rock drilling conditions. The solid piston design is made from an advanced material that is case hardened, combining high strength with supreme wear resistance. The high frequency, reciprocating piston is designed to strike the bit with maximum force. An innovative new design, unique to Rockmore hammers, reduces the number of hammer components, thus reducing the amount of component wear points, making hammer service simpler and less expensive.

Unique lead threads on the Top Sub and Driver Sub ensure easy coupling and uncoupling of the hammer.

The ROK 500 and 500Q are 127 mm diameter class hammers which accept industry standard drill bits with 12 spline Ingersoll Rand QL5 / QL50 shanks. Recommended bit sizes range from 140 to 152 mm. These new hammers are offered with multiple pin connection options: 2<sup>3</sup>/<sub>8</sub>" API Reg Pin, 3<sup>1</sup>/<sub>2</sub>" API Reg Pin and Cubex #28 pin with splines.

## MINCOM

Mincon has announced its newest range of DTH hammers and bits – the MC Range. This patented range of tools is unique in that they do not use a foot valve on the drill bit. A patented bit retention system allows for a fully supported bit in the bit chuck. This provides for a much sturdier shank design greatly reducing the possibility of drill bit shanking. With more spline engagement than a traditional DTH bit the amount of spline wear is greatly reduced when compared to other traditional drill bits, Mincon says.

The MC Range has been specifically built for applications where high penetration rates are important. This unique design concept

*Mincon says "focused on providing innovative solutions to today's blasthole contractor the MC Range of DTH hammers and bits addresses the dual needs of productivity and longevity"*

provides much greater impact energy and drill performance maximising productivity in almost all ground conditions.

With an optimised air flow and exhaust system



the MC range is designed to be able to easily collar the borehole and continue to maximise flushing while drilling. The tools work efficiently on both low and high volume air compressors. With size ranges from 3" through 12" the MC Range of DTH tools can cover the smallest to the largest blasthole sizes.

Mincon also offers a unique backreaming backhead option on its hammers. This system is for the most extreme blasthole drilling conditions when getting stuck in the hole is a problem. This system allows the hammer to dig its way out of a collapsed hole, preventing expensive downtime and tool loss.

The latest addition to the Wassara Drilling Systems family is the W70 hammer. It extends the bit diameter range available between the existing drilling systems and is primarily designed for nominal bit diameters of 82 and 89 mm. It comes with a new drill bit optimised for water powered drilling. The patented and trademark registered drill bit is called W-Bit™.

With its narrower diameter range, this drilling system offers new possibilities in applications where today diamond drilling and/or top hammer drills are used. As an alternative to diamond drilling, the W70 offers the advantage of high ROP and the possibility of reduced total drilling cost.

As an alternative to top hammer drilling, the W70 offers the advantage of drilling longer holes with low deviation.

Advantages:

- Powerful - High power output, high frequency and energy level per blow, for high-power drilling where access is limited
- Light - Hammer weighs only 22 kg. Overall lighter drilling equipment for easier drilling and system handling

In core drilling, Atlas Copco says it "realises that today's companies need their tools to work as hard as their drillers do. Drilling contractors are facing greater challenges than ever before. Not only are they drilling deeper,

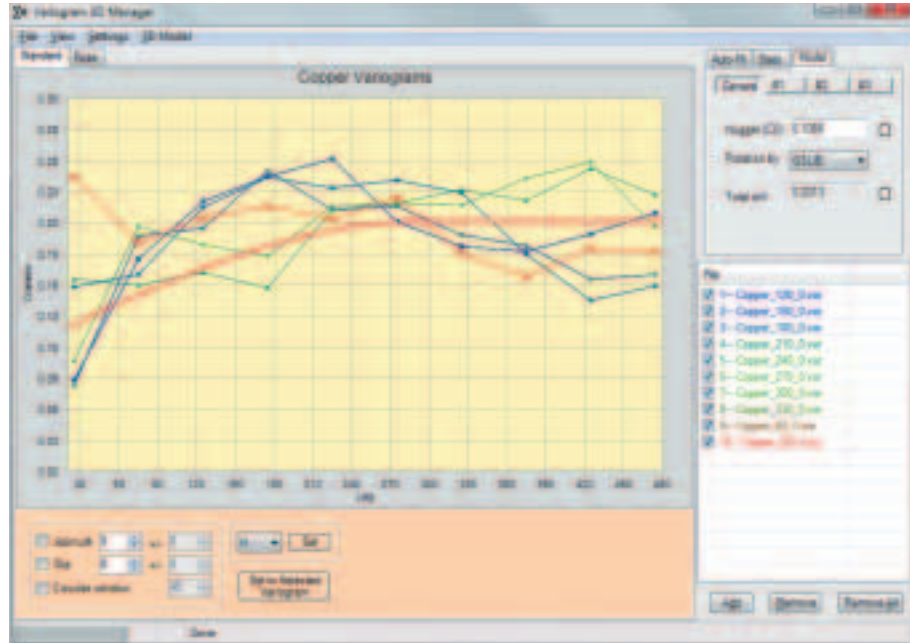
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in more challenging conditions, but they are constantly looking for ways to conduct a safer, more productive operation.”

What began with last year’s Excore Premium diamond tools, has evolved into this year’s Excore Solution. The new Premium ITH tools are a direct response to customer demands for speed, safety, and durability in the field. Atlas Copco started with a simple question: what if safety was automatic? “We started upgrading our line about 18 months ago and spent a lot of energy and time doing it - we have been successful, but it’s an ongoing project for us,” explained Atlas Copco Product Line Manager (Core Drilling ITH) Stephane Goupil.

New design approaches, and a rigorous field-testing phase, yielded extremely positive results for new Premium ITH tools. Forage Azimuth in Quebec, Canada, tested the new product for over a year and Director of Operations Yvon Mercier said that his company and crews were very impressed. During their tests, Forage Azimuth noted a 15% increase in productivity, especially on deeper drilling projects and some leading edge innovations in safety.

The ‘auto safe’ overshoot is a major feature, the only overshoot in the world to feature a fully automated safety lock that results in a faster cycle speed, increased productivity – and most impressively, automatic safety, Atlas



Copco says. The Excore Solution also includes innovations to the head assembly, which now features a unique two seal switch out to allow quick transitions between surface and underground drilling; and the modified MO-EX Thread that provides a minimum of five times more pullback than normal threads. “While these tools are adaptable, they achieve optimum results when used together, a huge benefit of The Excore Solution,” the company says. “[It]

will revolutionise the industry with high-capacity, heavy duty ITH Tools that are stronger, lighter, and more ergonomic than ever before. The Excore line was designed as a complete solution to provide safer, more productive tools that are well suited to any challenge.”

## IT for surface drillers

Mintec says its new “MineSight Torque represents a new generation in drillhole management, and [the recent] release of Version 1.50 features several improvements to help tackle the complexities of geomodelling.

MSTorque manages drillhole, blasthole, and other sample data in a Microsoft SQL Server database. Version 1.50’s Calculated Sample Attributes/Scripts feature allows new fields to be created by calculating dynamically from existing data. The calculated field might be as simple as an equivalent grade or NSR expression, or it might be generated via a user defined script.

A History Tool keeps track of project sessions and key events, such as Import Data, Modify Data, and Create Backup. It logs all information for review at any time.

Whether it’s column sort order, column width, or selection order, the layout of MSTorque Manager view can be customised and saved for use in future sessions.

There is also a new swath plot tool, MineSight Data Analyst Version 2.50 providing comprehensive statistical and geostatistical analysis of drillhole, blasthole, and model data. It creates vertical and horizontal swath plots through a MineSight block model. Tonnage and any number of grades can be plotted. Several other enhancements are included in the upgrade, which followed the release of MineSight Torque Version 1.50. **IM**

## ROCKMORE